The Province of Alberta

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

IN THE MATTER OF THE GAS RESOURCES PRESERVATION ACT

AND IN THE MATTER of a Joint Hearing to determine various questions relating to the proposed Export of Natural Gas from the Province of Alberta.

I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

Session: SEPTEMBER 13th, 1951.

Volume 4.

I N D E X

VOLUME 4.

13 September 1951.

W I T N E S S E S

E X H I B I T S

Volume 4.

September 13, 1951.

MR. McDONALD: Mr. Chairman, I have a representative of the Union Oil Company of California here. I will put him on the stand now.

BASIL P. KANTZER, having been duly sworn, examined by Mr. McDonald, testified as follows:-

Q Mr. Kantzer - is that the right way to pronounce your name?

A Properly pronounced Kantzer.

Q Would you be good enough, Mr. Kantzer, to tell us your position with the Union Oil Company and very, very briefly your experience in the gas business?

A At the present time I am manager of the Natural Gas and Gasoline Department of the Union Oil of California. Professionally, my background can be briefly described as being a graduate of Stanford University in 1934 with a B. Sc. in engineering, with considerable graduate work taken at the University of Southern California and I am a registered Professional Engineer in the State of California. In the past I have variously been engaged on the Pacific Coast field operations for the Union Oil Company, their Chief Production Engineer. In 1947, Chairman of the Engineering Board of the Committee of California Oil Producers and at present Chairman of the Pacific Coast Chapter of the American Institute of Mining & Metallurgical Engineers. I believe that might suffice.

Q Thank you, Mr. Kantzer. Now there has been prepared a submission on behalf of your company, Mr. Kantzer, to which is attached one map, a property map, and a second, a

cross-section map?

A That is correct.

Q I think since it is a brief statement if you would read it into the record it would be all right.

A I will be happy to do that. There are two attachments, one a generalized cross-section map of the Peace River area. I think most everyone here is familiar with that.

THE CHAIRMAN: We will mark that Exhibit 9.

MR. McDONALD: Exhibit 9 would be, what shall we call it, Union Oil Company Limited Map showing interests in the North West of Alberta?

THE CHAIRMAN: Mark the presentation as a whole Exhibit 9.

DOCUMENT NOW MARKED
EXHIBIT 9.

Q MR. McDONALD: Would you carry on with Exhibit 9, Mr. Kantzer?

A The exhibit reads as follows:

The Union Oil Company of California jointly with Hudson's Bay Oil and Gas Company Limited control the acreage shown in yellow on the attached map which amounts to approximately 1,674,000 acres. Acreage controlled solely by Union Oil is shown in red and amounts to approximately 500,000 acres.

The acreage shown in blue and green colors are farmouts which are being explored jointly amounting to approximately 100,000 acres.

A general regional cross-section extending from the westerly border of Alberta to a point due south of the town of Peace River covering a distance of

approximately 100 miles is presented which depicts the stratigraphic possibilities for oil and gas accumulation in the general Peace River area. The numerous "pinch-outs" and truncations of formations afford excellent opportunities for gas accumulation both from a stratigraphic and structural standpoint.

In the Tangent area it is estimated that 22,000 acres will be productive of gas from the Peace River sand and the Gething sands of Lower Cretaceous age. This area is all within proven limits of closure. The Triassic sand production may not prove as extensive as the Peace River and Gething sands, however considerable gas was encountered in the Nos. 1, 2 and 4 North Tangent wells.

In the Union-Hudson's Bay-Texaco well of the Dunvegan area the Peace River sand and the Gething sand has been found to contain large volumes of high pressure gas. It is estimated that 10,000 acres lie within the productive limits of closure.

On the remainder of the Dunvegan area it seems likely that considerable gas will be present in the Peace River sand and possibly the Gething sand.

At Valley View, Pacific Petroleums have discovered gas in the Peace River sand on acreage controlled by Hudson's Bay Oil and Gas and Union Oil Company of California. It is difficult to predict the area which might eventually prove productive though indications are that a sizeable area is involved.

Electric logs, micro logs, drill stem test information and perforation tests on all of the exploratory wells are being submitted by our partner the Hudson's Bay

Oil and Gas Company Limited, consequently that exhibit will not be duplicated by Union. Complete information on all wells drilled in this area has been reported to the Conservation Board.

The Union Oil Company and Hudson's Bay Oil and Gas Company Limited will undertake an extensive exploratory and development program for additional gas reserves if an adequate market for gas is made available.

To date the search for and discovery of gas has been incidental to the search for oil in the general Peace River area. If adequate outlet for gas was assured considerable gas would be uncovered which has hitherto been disregarded. In some instances gas sands may have been "mudded off" before being protected by casing.

The Union Oil Company of California has expended approximately two million dollars to date in the search for and development of oil and gas in the general Peace River area. This expenditure includes land bonus, rentals and exploratory work.

Q Mr. Kantzer, this work that has been carried on to date has been in the nature of exploratory work?

A Entirely, that is correct.

Q And do I interpret your statement here that when development work has been carried on that the result obtained could be expected to be better than those to date?

A I think in general any programme that is directed at exploration of oil and gas possibilities through a thick section of sediment that generally they complete wells that would be less effectively completed than those if they were drilled directed to completion at an oil or gas

sand from a given horizon. By that I mean that extended drilling through directive sands at greater depths often, and in many cases have resulted in impairment of the permeability of the sands at other penetrated depths of the well which otherwise would have produced if that penetration had been taken rather than drilling deeper. I think a development programme would have been designed differently than an exploratory programme would be designed.

Q And your new programme would depend on the availability of a market for gas?

A Entirely. Our Company Council's efforts right now, until such a market becomes available, will be entirely exploratory work, but very certainly a great deal of development work could be entered into immediately if an outlet for the gas in the Peace River were to hand.

Q And you have so stated in this submission that your company will proceed with the development work when an adequate market for gas is made available?

A That is right.

Q Apart from this submission, Mr. Kantzer, you have had experience in connection with the storage of gas, both sour and sweet gas fields?

A Yes, that is correct.

Q Can you briefly state one operation, that is the Playa del Rey field referred to by Mr. Dodge yesterday. In view of the fact he referred to you I thought perhaps you should have an opportunity of saying something about it?

A Rather a brief discussion of the del Rey gas storage project,

just dealing with the pertinent facts that might be of interest to the Conservation Board and the people present here today. The operation was conceived as a peak load delivery mechanism for balancing off the load in the Los Angeles area during the last war. This worked very successfully supplying the reserve for the area which might be termed as one large cushion of some billion feet, with a working amount over and above that roughly of a billion and a half feet. It fluctuates between a billion and two billion feet of usable delivery. The delivery rates up to some 8 to 10 million feet per hour are currently available from the reservoir. Its originally designed rate was between 3, 4 or 5 million feet per hour. The reservoir itself was originally oil in its entirety. There was no original gas there. It was largely depleted at the time the project was begun by a process of gas injection by the then Defence Corporation, a department of the Government who in turn rented to the utilities companies in Southern California. The production has been of low gravity oil with a low gas-oil ratio. It started low and got down to a pressure of some 50 pounds at the time the project started. The field was known as a sour gas field at that time and some speculation had been entered into concerning the success of injecting sweet gas and delivering it directly into the Gas Company's transmission lines from the reservoir. The content of hydrogen sulphide was quite reasonable. Prior to injection there were 12 grains per 100 cubic feet of hydrogen sulphide but the stored gas that was injected has been returned at a content of less than 2/10ths of a grain

per 100 cubic feet, roughly 1% of the original sulphur contamination. So for the last 9 years this storage has been pumped up and emptied in the winter time, not emptied but used in tne wintertime without any difficulty. The Union Oil Company's role in the operation and the authority with which I speak was as agent for the Governmental department which owned the project and we operated as their agent for that department of Government and the utility companies. I should be happy to answer any other questions. I know it is a rather brief statement but that shows the way that project has operated. The gas company in turn has a second and much larger project in California known as the Golleta Gas Storage Reservoir located near the town of Santa Barbara, North of Los Angeles. That project is considerably larger with deliverability rates up to 100 million feet an hour available to transmit to the Los Angeles metropolitan area. It is a sweet gas field reservoir, sandstone, and there is a third project that has been used by one utility company located in the San Joaquin Valley. As a matter of fact there are two projects there and both of them present further elements to take care of the load variation in the load of that utility system, one of them is known as the Buena Vista Hills field and the other is a 27.B unit project. In addition to that there are two or three other storage projects under consideration at the moment for further equalization of the low load factor.

MR. McDONALD: That is all the questions I have, Mr. Chairman.

THE CHAIRMAN: Anybody else wish to question Mr. Kantzer?

MR. C. E. SMITH: I have one question. I do not know whether other counsel are indicating that they have not any. I did not see anybody get up.

MR. McDONALD: There was one other point, Mr. Chairman, that was with regard to this question of sand face pressure drop that was discussed and presented by Dr. Hetherington yesterday. Have you anything to say about that that might be of interest to the Board?

A It might be useful and of course I cannot say whether it would be or not. The formulas and procedures and methods for oil and gas production in the State of California are on a voluntary basis. The State has no regulatory law. We do have, however, a committee known as the Conservation Committee of the California Oil Producers who collectively and voluntarily meet to solve our mutual problems and to equate the equities in the fields to the various operations. As part of that Committee an Engineering Board has been set up and consists of 12 members representing the operators in California from year to year on an elected basis. That committee has in the past and is now studying the problems of each field in California, which is on what we term a restricted basis, where some drilling and production has indicated an increased recovery and a large number of oil fields are considered and in each case the allocation of production and so on and individual problems are studied and to meet these conditions let me say it is necessary to consider such things as Mr. Hetherington talked about yesterday, namely, the bottom-hole condition of production.

Basil P. Kantzer,
Dir. Ex. by Mr. McDonald.

He called it the sand face, I believe. In my thinking I would call it bottom-hole differential, that is the difference between the bottom hole pressure of a flowing well and the static reservoir pressure.

(Go to page 250.)

A That is one of the factors that is generally considered in many of these allocation formulas in our State. In addition to that there are other things that do fall in the same general category. For instance, the volumetric withdrawal of fluids from the reservoir calculated in terms of reservoir volume rather than in terms of surface measurement. Those factors are generally considered likewise. Does that answer your question?

Q MR. McDONALD: That is all I have, Mr. Kantzer.

EXAMINED BY MR. C.E. SMITH:

Q Mr. Kantzer, with regard to storage where you have a situation where you have 600 grains, assuming we have 600 grains, say, can you assist the Board by giving us any help of what might occur in that event? You have illustrated the fields down in California, the storage fields you spoke of. Can you immediately give that thought some help now?

A It is rather a difficult thing to predict what would happen. I am not too familiar with that field. I imagine you are referring to Turner Valley?

Q Yes?

A I am no expert on Turner Valley.

Q I gather you have not had an opportunity -

A I have not had any opportunity to study the field. It was suggested to me it might be useful to recite an experience that did involve a sour gas storage project. What would happen in Turner Valley, I, of course, could

not even qualify to answer your question.

Q The figure itself does not help you enough to give an opinion? I suggest 600.

A 600 is insignificant so far as I am concerned personally. I think this, though, there have been numerous injection projects, whether they were designed for storage purposes specifically or for cycling purposes or for some other reason which might demonstrate that fluids move in these gas injection projects in a manner that might suggest that once a cushion is put into such a reservoir as Turner Valley it might act like the Playa del Rey did in California notwithstanding the difference in sulphur content.

Q It might act the same way as in Playa del Rey?

A Yes, that is right.

Q The best you can say is it might act in the same way?

A There is experience from these other type projects that would indicate, for instance, I think in one case offhand, not at all a sulphur gas but a condensate type of reservoir in which the cycling problem was reversed so that the well that had been on injection for a couple of years putting dry gas back into a wet gas reservoir was reversed, the plan was changed and it was decided that that well should function as a producer. The records on this well indicate that all of the dry gas was injected into the well was reproduced before the appearance of wet gas and allied fluids in the reservoir.

Q And that indicates what?

A Whether the sulphur was there or whether it was not there

at some time in both of those cases, it would indicate that that might not be a controlling factor.

Q You have no concrete example of anything in the nature of what I have just suggested by way of experience?

A No, I have had no experience with a hydrogen sulphide content as high as that you refer to.

Q Just one other question, Mr. Kantzer. Has Union any contracts with any of the applicants to supply gas, whether they be option contracts, firm contracts or anything else?

A No, sir, they do not.

Q So that it may be for the assistance of other people like yourself here, you are not presently appearing here as a witness particularly on behalf of Mr. McDonald's clients, is that a fair way of putting it?

A I would say not, that is right.

Q I should go further, in fairness. I suppose you would be quite willing to enter into contracts with anybody if you got the price you want?

A We are looking for a market for our gas, that is right.

Q But there is not presently any contract between your company and any of the applicants, is that correct?

A Yes, that is correct.

Q That is all. Excuse me a moment, sir. Mr. Macleod has just suggested that probably subject to your contract with Montana Power. I used the term "present applicant".

A That is right, with that exception. As a matter of fact, I am not sure whether they are a present applicant or not.

Q Not Montana Power, I do not think, although I have a

hard job keeping up some times.

EXAMINED BY DR. GOVIER:

Q Mr. Kantzer, I wonder if you could help the Board by telling us just what you would look for if you were faced with the problem of trying to find a storage reservoir to satisfy a peak deficiency of, say, oh, 1 or 3 million feet an hour? What would you look for if you were trying to find such a reservoir?

A Such a reservoir obviously would have to be a permeable one. Delivery rates of this order could be economically met with a minimum of wells drilled into what I would call the high permeability side.

Q Could you put a number on that?

A Well, if one could get a reservoir with a darcy permeability it would be 10 times as good as one with 10 darcies or 100 millidarcies.

Q What would you say the minimum would be for solving such a problem?

A It would be entirely on the thickness of the reservoir under consideration. We have considered reservoirs of average permeabilities of around 50 millidarcies where the sand thickness, however, ranged into several hundred feet, with the millidarcy feet or production formation open and the well was just as effective as 1/10th the amount of the interval with 10 times the permeability. This is a very difficult thing to answer.

Q Would this be of help, Mr. Kantzer, could you indicate the minimum millidarcy feet which you think would be of

interest in selecting a storage reservoir for, say, 1 or 2 or 3 million cubic feet an hour?

A No, sir, I could not. However, for the information of your Board I could give you some information of the millidarcy feet available to those storage reservoirs. I do have some information on that.

Q I think that might be of help. Do you have any experience or do you know of any instances where storage, where limestone reservoirs are used for storage purposes?

A No, sir, I do not.

Q Do you know of any reason why limestone reservoirs would not make suitable storage reservoirs?

A I see no reason why they should not.

Q Would you be at all alarmed if the reservoir under consideration was one which was rather seriously faulted?

A For purposes of storage, I think that I could generally answer your question that the fault of nature of a reservoir might have its effect on the cost of operating the storage operation rather than in any other direction, and while any such a highly faulty structure as perhaps you are referring to might of course be only useful in so far as a small part of the reservoir is being concerned. It might be useful over a larger part of that reservoir where the fault is not in existence. Conceivably you would need more wells to operate such a reservoir.

Q How would you go about arriving at the size of reservoir that would be desirable for this problem I am talking about?

A I think that one would have to of course look first at the problem that has to be answered. What are the peaks that have to be ironed out in the system under consideration. Once having determined that, I think a reservoir that would have a factor of, oh, say, 4 or 5 times that requirement would satisfactorily answer the problem. In each case we have seen with a cushion apparently needed to act as a springboard, I guess might be a good term for that.

Q When you say 4 or 5 times the requirements, do you mean 4 or 5 times the annual peak production?

A Yes, so that an annual cycle could be satisfied.

Q Would there be any advantage if the reservoir was 30 or 40 times the annual requirements?

A None other than except from the pressure requirements. Conceivably if your reservoir was too large and the amount of gas that was going to be stored and the amount to be withdrawn each year was small in relation to the size of the reservoir, the injected gas would exhaust that low pressure and considerable pressure costs would accompany the use of the reservoir for that purpose.

Q In your experience, somewhere around 4 or 5 times the annual requirements would hit it about right so far as the pressure build-up, is that it?

A In one case that was the size of the reservoir that I have knowledge of. The other case the reservoir was used to its ultimate. In other words, the size of the reservoir - as a matter of fact, it is a little bit less than the size of the requirements. It is actually pumped

up to full capacity and unloaded.

Q Which is the better operation, Mr. Kantzer?

A Well, considering the hazards of the storage business and normal risk and hazard in the general understanding of oil fields, I would say it would be better to have some extra size in the reservoir than to not have it.

Q In the case of Turner Valley, do you think it possible that a portion of that reservoir, perhaps separated from the rest of it by faulting, might be suitable for storage purposes?

A I will have to qualify my answer as I did with Mr. Smith. I am not a good friend of Turner Valley. I haven't ever studied the field. I do not think it would be fair for me to answer that question. I just do not know enough about the reservoir. If it is a normal animal the fact that it is faulty - I say, if the reservoir were normal in other respects the fact that it was faulty would not deter me in considering the possibilities of it as a storage project.

Q Maybe we can get a little more specific. Supposing you had the job of looking into the possibilities of using all or part of the Turner Valley field as a storage project to meet a certain peak day deficiency or peak day requirement which was going to grow at a certain rate over a period of years, what would you look for in studying that problem?

A Given knowledge of what that peak requirement was both in terms of the peak hourly deliverability, which, of course, the Utilities companies are forever interested in,

and in terms also of the annual requirement for those deliverabilities, I would then pick a reservoir whose demonstrated net void space or production performance history would indicate that enough room were present in the void in the reservoir to, say, give us that 4 or 5 times factor of total volume. Then I believe the next thing that one would look for would be the ability of wells drilled into that field to produce gas at the required rate indicated from the rate requirement. Having that satisfied, probably either the size of the wells then in existence or the drilling of additional wells to complement the ones already there, one would have to look to the possibilities and the tightness of the reservoir. Is it a good balloon or is it going to leak? If it is going to leak, where is it going to go? Of course, one would have to have assurance on that point.

Q The matter of fault would be particularly important there, I suppose?

A Not particularly, it could be. There again, the production performance of the field would be about the only way one could determine whether or not a fault was going to act as a barrier, a partial barrier or no barrier at all.

Q You would not have any millidarcy feet figure in your mind that you would be looking for as a minimum? You do not have it at present, anyway?

A No. As I say, that is entirely a function of the size of the project that you have in mind. A little one is going to take a few and a big one is going to take an awful lot of them.

Q What about this sour gas problem? Suppose the sulphur content is 600 grains, what would you do about it?

A Obviously it would require a considerable amount of study. I would do that.

Q Do you think a storage project would be feasible if re-scrubbing of the produced gas was necessary?

A It could be feasible, yes. There again the economics of gas supply, the worth of the holder as an integrated part of the gas system, would have much to do with whether it would be economical or not. I could see how it could be when I look at the case of holder service, and service installation. That would be a very small part of that, I guess.

Q Do you have any figures, Mr. Kantzer, that would help us in gauging the reasonable cost of storage to meet peak loads? That is, can you quote any figures by Mcf. from the fields that you are familiar with?

A No. They would be exceedingly variable, the range would be terrific. I say again, the circumstances surrounding the inception of the project, the ownership of the project when it starts, have much to do with how much the operation of the project itself is nominal. The costs usually are greater than just operating the project, the cost of acquisition, equity adjustments, the usual obligations that go to assembling various properties into a unit, if you want to call it that, for purposes of storage.

Q Well, what about out-of-pocket operating costs, have you any figures on that?

A Not on the tip of my tongue, no. We operate at Playa del Rey - oh, I can describe the operation to you. I imagine it would be all right with the Government to let you have some information on that. We could request it for you. We act as their agent only in that operation.

Q This is the way it might help us, Mr. Kantzer, if we are considering the possibility of a storage project we would like to know whether the cost of that project is average cost or low cost or very high cost, and if we could get any information on costs elsewhere it would give us a yardstick.

A I will be happy to undertake to obtain the information in that regard for the Board if you would like.

Q It would be very helpful and we would appreciate it.

A I would much rather do that. We have a 2-man operation. The cost is very nominal, I will tell you that, at the moment. The amount of operation needed to satisfy the pressure conditions existing in the system is a sizeable cost. However, that is a cost that I would think would be no different for a project that you might have in mind than any of the others that are now in operation.

Q What is the compression ratio there?

A The compression ratio in our case is from 200 pounds to a maximum of 1100 pounds, a little over 5 to 1.

Q And 1100 being the maximum?

A The maximum reservoir pressure, that is correct.

Q And on the question of predicting the future deliverability of wells in a storage project, has it been your experience that back pressure tests of the wells as producers prior to any storage is a good indication of their future delivery capacity?

A Yes, it certainly is an indication of the magnitude or the effectiveness of the well as it produced when storage is in operation.

Q Input operations seldom affect the delivery rate?

A We have had, although I am not directly familiar with some of the other operations, we have had some trouble with the dry gas stripping certain of the light fractions from the residual oil in the sand, and forming apparently a tarry-like substance, which has in cases obstructed and impaired the injectivity of wells. However, in no case has it impaired the producing ability of the wells. And we have developed methods and procedures by which the injectivity capabilities of the wells can be restored by selected solvent action, certain solvents being put into the well and backflowing the cumulative material back out of the well. We have been able to maintain those wells down at that project at substantially the same basis at which they started 8 or 9 years ago. There has been no change at all.

Q Are the injectivity, as you call it, and the productiveness about the same?

A Well, it is hard to relate those two things, but I would say yes. I think the answer to your question is "Yes".

I think it comes out a little easier than it goes in, but nobody has been able to figure out why.

Q Thank you.

MR. McDONALD: That is all I have at present, sir.

MR. PORTER: I will call Mr. Trostel.

.....

EVERETT G. TROSTEL, having been duly sworn, testified as follows:-

MR. PORTER: Mr.Chairman, this is a continuation of a presentation of the application of Canadian Delhi and Trans-Canada which was initially undertaken at Edmonton on the 7th of May and adjourned to this time on the 10th of May. The witness, J. F. Doherty, concluded a review of the different exhibits which he since has, or which have since been developed in the light of subsequent work. I tender now Volume 3 which is entitled "A Supplementary Report on Natural Gas Reserves of the Province of Alberta", as an exhibit.

THE CHAIRMAN: That will be Exhibit 10.

VOLUME 3,"SUPPLEMENTARY REPORT ON NATURAL GAS RESERVES OF THE PROVINCE OF ALBERTA" MARKED EXHIBIT 10.

MR.PORTER: I am calling the witness who has just been sworn to prove the contents of this book and to describe the method in which it was compiled, but I think I should outline,perhaps, the program that I propose we shall follow, if it is agreeable. It will be recalled

that Mr.Doherty covered Volumes 1 and 2 which had been prepared under his supervision with the aid of the staff of DeGolyer and McNaughton. After the hearing in Edmonton, Mr. Doherty undertook to do work other than that which he had been doing for DeGolyer and McNaughton, and will go to his new work at the close of his evidence at this Hearing. Mr.Trostel then took it over and the work has been dovetailed under their supervision over the period of the preparation of this document. I propose to call Mr.Doherty to deal with those fields and figures in 1 and 2 that are projected in 3 in the light of subsequent developments, and then to call Mr.Trostel to deal with the content of 3 that is made up of fields in addition to those that were dealt with in 1 and 2, and has been projected in 3, because 3 contains two things, a projection of the fields studied in 1 and 2 in the light of subsequent information, and an examination of fields not dealt with in 1 and 2.

THE CHAIRMAN: Does Volume 3 contain all the data that was contained in Volumes 1 and 2 in respect of fields that Mr.Doherty prepared the information on?

MR. PORTER: No, with respect to the fields that Mr.Doherty prepared the information on, we still have to go to Volumes 1 and 2, but as to such of them that have undergone some change, it is in Volume 3.

THE CHAIRMAN: As I recall, we agreed that Mr. Doherty would be available for examination at this time as counsel other than Board counsel did not cross-examine him.

MR.PORTER: I propose to put him on as soon

as Mr. Trostel has proven what is in this book, and the reason for that is that I doubt the wisdom of subjecting Mr.Doherty to cross-examination on the contents of Volumes 1 and 2 when in many instances his answer will be, "Well, my view about that is now expressed in 3." I am going to ask this witness to stand down as soon as he has qualified himself and proved the make-up of this book and then to call Mr.Doherty and submit him to examination.

Q Mr.Trostel, I think it might be useful if you would tell the Board who you are and what qualifications you have that entitle you to ask the Board to pay some attention to your professional opinion with respect to the items under discussion?

A My name is Everett G. Trostel. I was born in Long Beach, California, on June 5th, 1909. I attended public schools in California, attended the California Institute of Technology in Pasadena, graduating from there with a Bachelor of Science degree in 1931. I did graduate work at Stanford University and the University of California in the subsequent years. I have an M.A. degree in Physics from the University of California in 1933. At intervals I took graduate work at the University of Southern California under John Dodge, who was then Professor Dodge, and I obtained a Master of Science degree in petroleum engineering in 1939. In 1949 I was awarded a Degree of Professional Engineering and Petroleum Engineering from the University of Southern California.

Following graduation from the University of California in 1933, I entered the employ

of the Union Oil Company of California in their Los Angeles refinery, at Wilmingdon, California, where I worked as an engineer and later in the Development Department of that company on electric de-waxing.

In 1935 I became petroleum engineer in the field department and had a hand in setting up the core analysis laboratory of the Union Oil Company at that time. In the following year I took charge of the bottom hole pressure measurement work of the Union Oil Company and the field interpretation. In 1937 I went into the head office as production engineer and made reservoir studies of the reserves and estimation of gas reserves. In that interval of time I was also on loan in one case to the State of California with regard to the matter of allocation of the gas in the Montebello field.

I worked on industry committees, the conservation committee of the California Oil Producers. I was first chairman of their so-called Depth Pressure Committee in regard to the use of bottom hole pressure measurements and the establishment of well potentials for allocation purposes.

In 1939 I did work essentially as a mechanical engineer in production operations engaged in the designing and installation of production equipment. In 1940 I was engaged in development engineering, drilling engineering, if you like, at least the drilling and completion of wells. Over that interval, that same interval, from '37 to '41, I was lecturer in Petroleum Engineering at the University College of the University of Southern

California.

In 1941, the Fall of 1941, I went to work for Mr. DeGolyer in the Federal Agency which is known as the office of Petroleum Co-ordinator, which later became the Petroleum Administration for War, as conservation engineer in the District 5 office in Los Angeles, where I was the Government representative on various conservation schemes and measures in the operation of oil and gas fields during the war. In fact, in that capacity I worked with Dr. Dodge, who was then with the Railroad Commission, and was instrumental in, I think, in getting the Federal Government to institute condemnation proceedings which took over title to the Playa del Rey gas fields, which permitted it to be put into effect as a war measure. In 1944, I became District Director of the Research Division of the Petroleum Administration for War, which was in charge of the Exploration, Reserves and Conservation Divisions of that office. In 1945 I left the Petroleum Administration for War and joined the firm of DeGolyer & McNaughton, where I am still employed at the present time as senior Vice-president of that organization. I have been engaged in appraisal and estimation of reserves in most of the oil provinces of the United States, in Canada, in Alberta, and in certain fields in South America.

I have done work on unit operation and have been instrumental in doing work for my company which was instrumental in unitizing at least two oil fields, oil and gas fields, which were unitized and placed on figures due to our work.

I am author, or co-author of several technical papers. I think the one of which I am the proudest is one I was co-author with Mr. Dodge and Mr. Pyle, entitled "Volumetric Estimation of Reserves" published by the A.A.P.G., in 1939. I believe that was one of the early papers that introduced the concept of the use of connate water in volumetric measuring.

I am a member of the A.I.M.M.E., the American Association of Petroleum Geologists, and the American Geophysical Union. I have been an officer of and have held several official positions with the A.I.M.M.E., and have been Chairman for Gas of the Petroleum Technological Committee of the Petroleum Branch.

I am a resident professional engineer of the State of Texas, a registered petroleum engineer of the State of California.

Q Well, now, as I understand it, the contents of Volume 3 are prepared by DeGolyer & McNaughton under your supervision, and the supervision of Mr. Doherty. In his case it is with respect to the contents in Volume 3 with regard to the material dealing with those fields covered in Volumes 1 and 2?

A That is correct.

Q Is that right?

A That is correct.

Q In other words, Mr.Doherty's work in Volume 3 relates to the fields originally covered in Volumes 1 and 2?

A That is correct.

Q I believe there may be one or two exceptions, but in

principle that is right.

Q Now, Mr. Doherty described to us in Edmonton pretty well as to what material is in Volumes 1 and 2, together with the principles that were applied. Can we say at the outset that, generally, the same methods and procedures were used in Volume 3 as he described with regard to Volumes 1 and 2?

A That is correct, sir, the continuity has been maintained.

Q Now,you had, of course, some help with regard to the preparation of this work?

A That is correct.

Q Can you give us an idea of the man-hours that are in Volume 3, which I think is of interest, because we know what was in Volumes 1 and 2?

A Approximately 6500 man-hours have been spent in the preparation of our exhibits for thie Hearing. Of that about 4000 man-hours was technical personnel and the rest was clerical.

Q How many men did you have on your staff?

A We counted up the other day, and we found that we have had 15 people working on this particular preparation at intervals. However, 6 people worked full time, continuously.

Q Now, with regard to those people, were any of those people people whose judgment was brought to bear on these matters?

A Absolutely.

Q Now, as to them, would you tell us something about the experience of some of them that might enable the Board to give weight to such conclusions as are theirs?

A I would be very happy to.

Q You might tell us something about some of the men that worked

on this?

Q Well, in our office we tend to have specialists, and areas of specialty, and I believe one of the prime specialists we had was Anthony Folger, who has devoted his time exclusively to the preparations of Volumes 1, 2 and 3. Mr. Folger was a graduate of the University of California in 1917, with a degree in geology, and he worked for the Standard Oil Company of California in the Pacific Coast states, Rocky Mountains, in West Texas, Porto Rico and other places. Following his work with Standard Oil he worked for Gulf, was employed by Gulf Oil and worked in the middle Central States, and was division geologist for an area which covered the Central States, Kansas, Wyoming, certain parts of Montana, Colorado and Oklahoma. I believe his work has been well recognized. He has received many distinctions from the standpoint of work that has been done for the profession.

I might say that after he left Gulf, he was for 5 years a consultant on his own, and during that period he worked throughout the entire United States and Canada. I believe he has done work in every Province of Canada with the exception of the Northwest Territories.

(Go to page 269)

He has been with DeGolyer & McNaughton for three years and his work with us has been primarily devoted to work in Canada and of that, primarily in Alberta. I mention Mr. Geoffrey Meyer, who in general was in charge of the availability and deliverability calculations we have, in addition to working with the reserves. Mr. Meyer is a graduate of Texas A & M. He is a Physical Chemist. He went with the Hanolind Company in 1939 and later on the Hanolind Buchanan. In 1944 he became a staff member of the railroad Commission of Texas.

Q , The Railroad Commission in Texas is the body for regulating and controlling the production of oil and gas?

A That is correct. They control the production of oil and gas in Texas.

Q The word "railroad" there has nothing to do with their judgment?

A No, sir.

MR. C. E. SMITH: I hope not.

A Mr. Meyer worked for them for a year before he went into the Air Force and on his return was the engineer for them in Austin. He held the large majority of the hearings for the 4-year period from February 1945 to February 1949 and was quite familiar with all types of procedures and conservation practices and general engineering that goes on in the fields in Texas. He worked for a short time with the Transcontinental Pipe Line ir Houston before coming to work for DeGolyer & McNaughton something over a year ago. He is well experienced in pipe line operations and regulatory functions. This could go on for some time. We have

Howard Low, who has devoted a good deal of his time . . .

Q I think perhaps I can shorten this by asking you whether the outline of the qualifications of these men is illustrative of the quality of the men whose efforts were applied to the production of this work?

A That is correct. We try to get the best men we can in our organization.

MR. PORTER: I think, Mr. Chairman, that that qualifies this volume. I now propose to ask you to permit Mr. Trostel to stand aside and to take Mr. Dougherty's evidence. I would like at the outset, if I may, to go through Volume 3 and project on the record any additions to what he has said about Volumes 1 and 2. When he has testified with regard to Volume 3 he will be available for cross-examination, not only on his previous testimony but on the testimony that is brought up to date, if that is satisfactory.

MR. C. E. SMITH: Could we not have Volume 3 marked as an exhibit now and keep the matter clear?

MR. PORTER: Volume 3 is now Exhibit 10. I propose subsequently to tender Volume 4 which is a composite production of estimated future availability of natural gas but I think it would not be proper to put that in at this time. However, I do mention that because I want to make copies available to those persons who are parties to these proceedings. I am sorry we cannot make them broadly available. When we undertook to do that in Edmonton it completely denuded us of our store and a great deal of this work had to be redone and at a cost that appeared to me to be prohibitive. So I hope those who would like copies of this

useful compilation will appreciate that it is not physically possible to distribute them broadly. So I propose to make copies of these available to those persons who are parties to this application and entitled to examine on them, but I am afraid we cannot make them available to everyone.

THE CHAIRMAN: I think that is fair enough, Mr. Porter.

MR. C. E. SMITH: Everybody else has been running out of submissions, Mr. Porter.

MR. PORTER: I would like to do it but it is just impossible.

MR. C. E. SMITH: I understand what you are saying.

MR. PORTER: I think you could stand aside, Mr. Trostel.

.....

JACK F. DOUGHERTY, having been duly sworn, examined by Mr. Porter, testified as follows:-

MR. PORTER: Mr. Chairman, is it understood that Mr. Dougherty is still qualified and under oath?

THE CHAIRMAN: I think we have been having all the witnesses re-sworn. But as far as qualifying him is concerned that is all right.

(The witness was then sworn.)

Q EXAMINED BY MR. PORTER: Now, Mr. Dougherty, you gave evidence in Edmonton which is recorded in Volumes 1, 2 and 3 and was related to the contents of Exhibits, books 1 and 2. Just a moment, maybe I can get the exhibit number.

MR. McDONALD: 4 and 4A.

Q MR. PORTER: Exhibits 4 and 4A. In Exhibit No. 10

that has just been tendered it is my information that some of the fields dealt with in Exhibits 4 and 4A have been brought up to date by you in the light of information available since Exhibits 4 and 4A were compiled?

A That is correct, sir. Yes, sir.

Q I suggest that you might complete your testimoney by adding to it your evidence with respect to those fields contained in Exhibit 10?

A Yes, sir.

In recapitulation of the fields which were presented in Volumes 1 and 2, 5 fields have been revised downward in reserve estimates, 14 have been revised upwards and arithmetical corrections have been made on 4, so that I propose to discuss very briefly in most instances and in some detail in several other instances 23 changes or revisions in Volumes 1 and 2 which are brought out in Exhibit 10, Volume 3. The first correction involves that estimate of the Brooks field which is to be found in Census Division 3 and as will appear first, if you will refer to Census Division 3, page 1, list 7 under Bow Island Sands, you will note that under the Column 14 appears the notation "Changes since April 15, 1951 minus 27,332 million cubic feet." The correction due to an arithmetical mistake, due to a mistake in the planimeter measurements. The second arithmetical correction is for the Brooks North East field which appears also in Census Division 3 on page 1 of that Census Division, line 8, Brooks North East, we found minor discrepancies in some of the calculations. I might preface this by saying that we made a very thorough check of the

previous work in 1 and 2 when Volume 3 was prepared, in order to eliminate such errors as we might be able to find. The net effect of the corrections in the Basal Alberta sand figures and in the Sunburst is a downwards revision of 29,400 Million cubic feet.

In Census Division 3 we have a revision for Countess which appears on page 1, line 9, which by drilling and revision or recalculation we revised our estimate downward by the amount shown in Column 14 as minus 48,192 Mcf. That is a revision involving one on Census Division 3, pages 1 and 11, the summary sheet in that volume and the details. I propose now to refer in Volume 3 to pages 7, 8, 9 and 10 which bring out our new calculations.

Q MR. PORTER: Which Census Division?

A Census Division 3.

Q MR. C. E. SMITH: Pages number 7, 8, 9 and 10 you are referring to?

A Yes.

Q MR. STEER: Still dealing with Countess?

A Yes, sir.

Q MR. C. E. SMITH: I do not want to interrupt but I doubt whether Mr. Dougherty gave us the reason for the 294 correction?

A That was an arithmetical correction in calculation, the mechanics of multiplying. If you will refer to pages 9 and 10 the basic reason for the revision is the greater detail afforded by drilling the Canadian Delhi Ohio Countess No. 1 well which appears in Township 21, Range 17, West of

the 4th, Section 14 on the North boundary of the field and the drilling of the Canadian Delhi Socony Rosemary No. 1 well, Township 21, Range 16, Section 22. The drilling of those wells enabled us to break down the Bow Island sands into two units as shown on page 9. Net 1st Bow Island gas sand isopachous map and on page 10 the isopachous map of Net 2nd and 3rd Bow Island gas sands. Our previous work involving 1 on page 10 of Census Division 3 was a composite of all three sands. We found with additional drilling we were able to break the sands down and that their gas saturation was not co-extensive as is illustrated by these pages 9 and 10; that the distribution of the 2nd and 3rd Bow Island gas sand is a far smaller area on the work we have done than is the 1st Bow Island gas sand. I might at this point add that although our estimate has been revised downward it appears now in the light of development as of yesterday or the day before that the drilling of the Smith C.P.R. #3 well in Section 22, Township 20, Range 15 West of the 4th, which lies approximately 8 miles South West of the centre of the Countess field, as shown on page 9, has recorded on a drill stem test 5 million cubic feet of gas, that is in excess of 5 million cubic feet of gas on the drill stem between 3103 and 3119 feet. The estimated rate is 9 million cubic feet per day with no water recovery. This well lies upon the South West beginning of a broad structural geophysical nosing on which the Countess field is located. In discussions with the Canadian Delhi staff yesterday, I learned that the geophysical picture suggests very strongly that

the Smith well is going to form a major extension of Countess or of this nosing to the South West. The Canadian Delhi have reserves amounting to a total of 15 sections which lie between the Countess field as shown on page 9 and the new well. It is expected that early drilling will extend the Countess field saturation considerably to the South.

Q MR. C. E. SMITH: Did you give us the location of the Smith well?

A Yes, sir, it was Section 22, Township 20, Range 15, West of the 4th.

MR. R. E. DAVIS: Range 15?

A Yes, sir. That is one township East of the map shown on page 9. South East, I beg pardon. The progress report on the South edge of Countess field as shown on page 9, the Canadian Delhi Sun No. 1 Leckie well in Section 25, Township 20, North Range 17 East is drilling at plus or minus 2000 feet to test the Bow Island sand. We do not expect that other than marginal production will be obtained on the basis of our work. However, the Sun and Canadian Delhi people feel that a commercial well will be obtained.

The next revision is an upward revision in the Medicine Hat-Many Islands field. The amount of 121,468 million cubic feet. This field data is shown in Census Division 3 of Exhibit 10 on pages 11, 12 and 13. The basic reason for this revision upwards is the development by the Britalta people of a connecting link between the old Many Islands gas accumulation and the Medicine Hat field. That is shown on page 13 of Census Division 3, Exhibit No. 10. The Britalta drilling,

beginning with Britalta Deep Rock No. 1 Many Islands in Township 13, Range 4 immediately East at the previously developed limit of the Medicine Hat field brought in commercial gas in substantial volume approximately two miles East of the easternmost Medicine Hat gas well, with virgin reservoir pressure. The other wells drilled by Britalta No. 2 in Township 13, Range 3, West, about the centre of the township and No. 3, Township 13, Range 2, West of the 4th. No. 4, Township 14, Range 2, West, No. 5, Township 15, Range 2, West and No. 6, Township 16, Range 3, West, all added materially to the area of the gas saturation extending the Medicine Hat field to the East. Our computations as revised were made basically on the correlation of the cumulative production from the producing part of the field and the decline in pressure. Basically we prepared isobaric maps as of the years 1950 and 1945, page 13 but inadvertently omitted to note isobaric map of the Medicine Hat field. I beg pardon. The date was omitted from the title. The title is there "Isobaric Map of Medicine Hat field September 1950." The computations are shown on page 11, Census Division 3, by the equal pound loss method, which would be another title for the pressure decline or material balance calculations on the proved area resulted in a computation shown on line 18, Column 12 of the initial recoverable gas to terminal pressure of 100 pounds p.s.i. to 160,977 Mcf. In order to gain a comparison of the volumetric calculation a volumetrid computation was made as shown on line 19, Column 4, using the factors shown from lines 1 to 15.

We wished to check the reasonableness of the estimate of the effective net pay thickness of the Medicine Hat gas sand which has ranged between 10 and 35 feet as indicated by a number of discussions with engineers who have estimated the reserves in the Medicine Hat field. We found that checking the electrologs of the Britalta well several wells drilled within the limits of the proved area of the Medicine Hat field that the thickness ranged between 5 and 35 feet and that the average of 18 feet which by a coincidence approximates the net pay thickness of Britalta No. 1 Many Islands well, as shown by the electric log and by the core analysis and the Many Islands Britalta No. 3, that 18 feet of net pay thickness - I beg pardon, 18 feet of net effective pay thickness, taking an average porosity of 15%, estimated interstitial watef saturation of 25% yielded an initial recoverable gas reserve to terminal pressure as shown on line 18, Column 4 of 799,686 million cubic feet, which was within reasonable correspondence of the equal pound loss method result as previously mentioned on line 18, column 12 of 760,977 million cubic feet. So that we feel that the volumetric calculation as to the total figure is within the elements of reality so far as the net acre feet are concerned. The areas shown on page 13 as probable and possible and as proved up in our opinion by the Britalta wells Nos. 4 and 5 and the isolated gas wells producing for local farm use in the surrounding area our reserve was estimated again by the volumetric method and by the equal pound loss method.

A By reducing on the basis of the electrical logs and such well log data as we could obtain, the average thickness in the case of the volumetric calculation is shown on line 5, column 5, from 18 feet to 9 feet. The pressure decline calculations corresponding to that figure were similarly reduced by a 50 per cent recovery as shown on line 18, column 13. The corresponding figures, volumetric calculation, line 18, column 5, 384,998 million cubic feet, and the quantity shown on line 18, column 13, 366,500 million cubic feet are again within comparable order of magnitude. A similar method of computation based upon the known thinning of the sands in the peripherealareas of the gas saturated Medicine Hat sand yielded the figures for the possible reserves shown by the volumetric method on line 18, column 7, quantity 164,121/million cubic feet, and by the equal pound loss method, line 18, column 15, 156,136 million cubic feet. Basically the pressure decline history as shown by the equal pound loss method are our basis for the estimation of reserves in the Medicine Hat field. We consider, as was expressed in the Edmonton proceedings, that our total of proved and probable reserves are considered as comparable to the figures or category as defined by the Oil and Gas Conservation Board as estimated reserves. I think that if you will keep in mind as we proceed through these corrections and revisions that by comparison between volumes 1 and 2 and 3 you will find that in a large number of instances the areas shown as probable and possible are now proved, or have shifted from possible

to probable by our definition as the drilling has progressed from a period May to September and that each day changes the classification in that direction on the average. The next correction -

Q MR. C.E. SMITH: Are you through with Medicine Hat? Are you going to another field?

A Yes, sir.

THE CHAIRMAN: We will adjourn.

(The Hearing then took a short adjournment.)

MR. C.E. SMITH: May it please the Board, Mr. Chairman, before proceeding, Mr. Bredin, City Solicitor for the City of Calgary, is present and I think asked to be here, and I would ask that he be recorded as one of the interested parties. That is correct, isn't it, Mr. Bredin?

MR. BREDIN: That is correct, sir.

Q MR. PORTER: You can proceed.

A Yes, sir. I would like next to refer to page 2, also in census division 3 of Exhibit 10. If you will refer, please, to line 14, the Patricia field or prospect, you will note under column 4 we have a downward revision of 530 million cubic feet, which is a correction of a mathematical computation of the previous estimate in volume 1, Exhibit 4. Also, on the following page 3, under Steveville South, which is the field shown as part of the group under line 21 in column 14, we have minor mathematical corrections totalling an upward revision of 1,322 million cubic feet on the computations for the Basal Alberta sand and the Sunburst sand.

Turning now to census division 4, page 1, line 10, under the total recoverable reserve for the Turner Valley field, you will note that there is an upward revision of 32,220 million cubic feet as shown in column 14. This is a revision of a tentative estimate given in volume 1, census division 4, page 1, in Exhibit No. 4. This revision was carried out by Mr. Frostel in a study of the Turner Valley field, and any cross-examination on that I would like to pass on to Mr. Frostel. It primarily results from some corrections on production and relating it to the reserve estimates previously made.

Turning down to census division 5, in Exhibit 10, under the Cessford field, line 2, a number of revisions have been made since the computations of April 15th, 1951. These revisions are complete up to approximately 30 days, 45 days past, as of August 1st, and subsequent developments, as I will discuss, if placed in this record would greatly increase the reserve available for sale. The net effect, however, of the changes and corrections between April 15th and August 1st has been an upward revision of 59,885 million cubic feet in the total Cessford area. We found a planimetered area which reduced some of the volumes, which was almost compensated for by the additional wells No. 5 and No. 6.

I would like now to take a bit of time to compare the development between the date, or contrast the development, between the date of Exhibit 4 and Exhibit 10. In volume 1, Exhibit 4, census division 5, pages 6 through 9, and in Exhibit 10, pages 9, 10 and 11.

MR. C.E. SMITH: What was the page of Exhibit 10?

A Pages 9, 10 and 11 in Exhibit 10, pages 6, 7, 8 and 9 in Exhibit 4, which is volume 1. A comparison of page 6, the isopachous map of net Viking gas sand, Cessford field, in Exhibit 4, with page 9 in Exhibit 10, a revised isopachous map of net Viking gas sand, Cessford field, would indicate that on page 6, in Township 24, Range 12, West, only one well had been drilled by Canadian Delhi, the No. 3 well in Section 2, in which we indicated probably Viking gas saturation. In the interim period No. 6 has been drilled, as shown on page 9, in Exhibit 10, in Township 24, Range 12, approximately 3 miles north of Canadian Delhi No. 3. This well indicated approximately 4 feet of Viking gas saturation, which is the approximate thickness as indicated by our previous isopaching as shown on page 6, in Exhibit 10, before the well was drilled. We, however, still consider that as only a possible reserve. The drill stem tests are not conformatory to the extent that we wish to call it proven or probable gas saturation. You will note also that in the interim period Canadian Delhi has drilled well No. 5, which is shown on page 9 of Exhibit 10, in Section 4, Township 25 south, Range 13 West. We indicated in April no possible, probable or proved reserves for that area. The well data of Canadian Delhi No. 5 confirmed that concept. Well No. 7 is shown on page 9, Township 25 south, Range 12 west, Section 5, also falls in that category, that prior to the drilling of the well we did not consider any Viking possibilities

and the well did not obtain any Viking gas. At this time I would like to add wells which have been drilled since the preparation of Exhibit 10. Well No. 9 is located in Township 25, Range 12, Section 30, which would be one mile west of No. 7, about four miles north of No. 7.

Q THE CHAIRMAN: No. 9?

A Yes, in Lsd. 4 - Lsd. 3, I beg your pardon. In the Southwest quarter of Section 30. That well did not encounter gas saturation in the Viking sand. We had predicted no gas saturation in the Viking sand.

If you will now turn to page 7 in volume 1, Exhibit 4, and page 10 in volume 3, Exhibit 10. We have maps reflecting the thickness of the Upper Blairmore net gas sand in the Cessford area. You will note on page 7, volume 1, Exhibit 4, that wells Nos. 5, 6, 7 and 9 do not appear. I would first like to have you compare the location of Canadian Delhi No. 5, shown on page 10, Exhibit 10, Township 25 south, Range 13 west, Section 4. That well when completed contained 10 feet of net Upper Blairmore gas sand. You will note on page 7, in volume 1, that we had shown the area as being within our probable reserve line of a thickness perhaps less in our estimation than 5 feet. We are reasonably pleased to have that well come in with 10 feet of net gas section. That will enable us to expand our provable or our probable area in a conformatory way and extend the reserves. We feel that these instances we are citing are illustrative of the definition

of our reserves and in a practical sense what we expect to happen to them as time progresses and drilling progresses.

I would like now to refer also to page 7, volume 4, Exhibit 4. You will note an irregular dotted area located primarily in Township 25, south, Range 12 west, which is shown as 0 thickness, merely indicating that on the pages of our structural and geophysical control and adjacent well control that we felt that area had excellent possibilities for producing gas. Since no well has been drilled we could assign no reserves to the area.

Now, refer to page 10 of Exhibit 10, and remember that Canadian Delhi well No. 7 is located as shown on the map in the centre of the south portion of that previously defined possible area. That well has been completed or is now in the process of completing as an estimated 15 million foot gas well in the Upper Blairmore sand. That possible area is now a proved area having definite gas saturation in substantial volume. To the north of this well about 4 miles as previously located, well No. 9 is now in the process of completion in Township 25 south, Range 12, Section 30. This well has obtained so far the greatest thickness of sand, possible net gas sand, of any well drilled by Canadian Delhi. These additional reserves stated as possible in our previous submission have not been computed for Exhibit 10. The wells are too recent. We are firmly convinced that they have substantial reserves in both the Upper Blairmore and the Sunburst

sands underlying the Upper Blairmore.

Q THE CHAIRMAN: Have you the core analyses on No. 9?

A I have just seen the core analyses as of yesterday and the electrical log. It appears that approximately 30 feet of net sands are present in the Sunburst and approximately 8 or 9 feet in the Upper Blairmore sand. The well is being perforated as of yesterday and before this Hearing is completed we will probably have some additional data.

Referring in passing to page 9 of Exhibit 4, and page 11 of Exhibit 10, you will note that the possible area which appears for the Upper Blairmore net gas sand was indicated as in our opinion being smaller than that, as being larger than that indicated for the Sunburst. The drilling of Canadian Delhi No. 7 confirmed that because no Sunburst sand was present. It was extremely thin and shaley. However, well No. 9 located approximately in the centre of that possible area is shown on page 9, volume 1, Exhibit 4, as the well which has this large thickness of Lower Cretaceous sand. We can not take too much credit for that, that is a circumstance, but there appear to be some indications that to the north the Sunburst is developing better and that, if you will remember our delineation of Cessford on the map in the exhibit in the back of volume 2, and in the present volume 3, that we have shown as being a continuous area of gas saturation and was our original concept before we had the

geophysical data. We then, for the reason that we felt it would be more practical to limit our work to such geophysical data as we had, to delineate those areas of present and possible and probable, having in mind that in the ultimate we expected the gas saturation to be extensive and to connect these possible and probable areas. At the present time the well has been located which will either prove or disprove that. This is well No. 8, which is located, if you will refer to page 10 of Exhibit 10, in Section 35, Township 24 north, Range 13 west, approximately in the centre of that section. This well is now drilling at 1600 feet. Our basic concept was that the minimum productive areas were the areas shown on our map exhibits, and that our hoped-for ultimate would be the areas shown on our large map exhibit.

Q MR. C.E. SMITH: What is the section number of that last one?

A Section 35. It lies a little bit south and almost mid-way between Canadian Delhi wells 5 and 7. Also, at this time well No. 10 has been located and staked and the rig from No. 9 will move to the location of No. 10. No. 10 is located in Township 25 north, Range 12 west, in the centre of the west edge of the small possible area shown on page 10 of Exhibit 10, in Section 27, approximately Lsd. 8. It is Lsd. 8, Section 27, Township 25 south, Range 12, West of the 4th. Also, Well No. 11 has been located, surveyed and staked in Lsd. 12, Township 25 north, Range 11 west, Section 1, being the southeast corner of Township 25 south, Range 11 west.

Q MR. PORTER: By the way, if I might interrupt at this point. It might be of interest to the Board, and I was reminded of it by the fact that you started three wells down there. Do you know how many wells Delhi is working in a search for gas?

A I think 15 at the present time between Saskatchewan and Alberta.

Q And how many of those in Alberta?

A All but one, with several locations awaiting rigs. This well No. 11 will be the tenth well in the 10-well program which Canadian Delhi has projected to explore the Cessford area. Well No. 8 represents a joint well with Hudson's Bay to develop the area, to prove up the concept the Canadian Delhi people and ourselves had developed regarding the extent of this gas saturation. Well No. 11 we hope will come in but we have not projected any possible, probable or proved reserves.

(Go to page 287)

In brief recapitulation of the well status: Well No. 1 is a gas well with an absolute open flow of 7.45 million cubic feet per day. Well No. 2 is a gas well with an absolute open flow potential of 4.95 million cubic feet per day. Well No. 3 is a gas well with an absolute open flow potential of 14.6 million cubic feet per day. No. 4 is an abandonment. No. 5 at present is pumping 20 barrels of oil per day, from a thin sand in the Lower Cretaceous. It is also a gas well by reason of gas saturation in the upper Blairmore and the upper part of the Lower Cretaceous. Well No. 6 is a gas well, awaiting test with an estimated potential possibly in excess of 3 million cubic feet per day. Well No. 7 is awaiting test, a gas well with an estimated potential of 15 million cubic feet per day, Well No. 8 is drilling at 6900 feet. No. 9 is perforating as of September 12th. No. 10 is located. No. 11 is located. In the ultimate result we would hazard a guess that the reserves of the Cessford area are something upwards of 3/4 trillion feet of gas.

I would like to refer now to Census Division 5 to the Craigmyle field under line 4, column 14, that is in Census Division 5, page 1, line 4, column 14, you will note we have a downward revision of the gas reserves in the amount of 11,867 million cubic feet in the Blairmore sand, a revision of our estimate in Volume 1, Exhibit 4, pages 1 and 12. Referring to pages 13 and 14, Census Division 5, in Volume.....

Q THE CHAIRMAN: What was the reason for the revision

downward in Craigmyle?

A That is additional drilling which I would like to elaborate on briefly. At pages 13 and 14,in Exhibit 10, this page 14 in Exhibit 10 should be compared with page 14 in Exhibit 4, Volume 1. Page 14, Census Division 5, Exhibit 1 - no, I will repeat that. Page 14, Census Division 5, Exhibit 4. And it is on page 14 in Census Division 5, Exhibit 10. These respective maps represent the isopachous maps of the Lower Cretaceous and Blairmore gas sands in the Craigmyle field. In the case of Exhibit 1, our original configuration, in the case of page 14, Exhibit 10,.....

MR. C. E. SMITH: In the case of Exhibit 4, not 1?

A Yes, sir, I am sorry. The basic reason for revision, which is minor in nature, was that the drilling by Canadian Delhi of their Link Lake No. 2 well is shown on page 14, Exhibit 10, in Section 1, Township 33, Range 17, West. We found no thickness of net effective Lower Cretaceous gas sand. The visual comparison of that location with our isopachous map, page 14 in Exhibit 4, would indicate that we projected something of the order of between 5 and 1 foot of net gas saturation. The sand was shaly. There was some fair indication of gas saturation, but insufficient in amount to consider as being a probable reserve. We thereby reduced the estimate.

The next one I wish to discuss is Oyen, which is also in Central Division 5, in the Eastern half of the Census Division, pages 16 and 17 in

Exhibit 10, and pages 24 and 25 in Census Division 5 of Exhibit 4.

I might at this time make brief mention of the fact that in the case of Cessford, the amount of data available for estimating reserves, the structural picture, and the probable extent of saturation are of a high order. That is, we had considerable geologic data, perhaps as much as we have on any exploratory project. In that case, our reserve estimates can be protected with some reasonable accuracy.

In the case of Craigmyle, the data was more limited. The field was apparently a little more of a stratigraphic trap of a local nature, and did not offer as close control, and we would expect and do expect that there will be a number of downward revisions as well as a number of upward revisions on our estimates, depending on the closeness of control, and we hold no particular brief for the infallibility of estimates, but at the same time we we feel that the data that has been made available to us has been exhaustively studied and the estimates are reasonable within those limits.

The next is Oyen. We have made an upward revision of 34,750 million cubic feet as shown on page 2, line 11, column 14. The revision primarily occurs in tbe Bow Island sand with a minor correction, a mathematical correction in the Madison limestone picture. At this time, between the time of the preparation of the estimate in Volume 3, Exhibit 10, and Oyen is shown

on the isopachous map, on page 16, a fourth well has been drilled which is shown on page 16, Township 28, Range 5, in Section 22, and we find ourselves in the anomalous position of the well coming in with very limited gas saturation, and at this date we feel that our original estimate was better than the revised, so that we are now back at the same place as we were in Volume 1, so that as of this date in contrast to August 15th, we prefer to cancel out that increase of 34,750 million cubic feet. There is some gas saturation, but the drillstem testing was not good, and I hope I do not embarrass anybody by that, but, nonetheless, several of the intervals that looked prospective, were not, so that I still have some reservations with regard to the adequacy of that test. However, we would prefer to consider the estimate as shown in Exhibit 4 for Oyen to take precedence over this most recent estimate.

Q MR. C. E. SMITH: Have you got the figures corrected so that I would not have to try to add and subtract that?

A No, this data we obtained about two days ago, so that we are trying to bring to bring you up to date as close to this Hearing as we can.

Q I take it that all I have to do is take the one total from the other, the 34,750 million cubic feet?

A Yes, sir.

Q Maybe I can do that.

A The next field is Sibbald, which is located in Census Division 5, East of Oyen, and the data on that field appears on page 1, in Census Division 5, page 1 and page 2, line 12, column 4, and we have an upward revision

of 18,469 million cubic feet above the estimates shown in Volume 1, Exhibit 4, Census Division 5, pages 1 and 23.

Referring to pages 24 and 25, Census Division 5, in Exhibit 4, that is our original Volume 1 - oh, I beg your pardon, we have introduced no isopachous maps, but the revision was based upon the drilling of an additional well, which data I will have to furnish you on cross preferably, because we have no map introduced in the exhibit, but that is an additional well in the Sibbald area which revised our estimate for the Viking sand upward.

The next field we consider is Bashaw, Census Division 8....

Q DR. GOVIER: Mr. Dougherty, were you not going to comment on the Youngstown townsite revision?

A That is one we had some trouble with in our records, finding it, to point that out, and we will undertake to dig that out before the Hearing is over, so that we can give you a complete picture on that. I understand that now the Youngstown townsite is a limited prospect. We have no estimate in either volume. That was an addition which was of sub-commercial character. That is, one well was drilled with a small show of gas in the well.

Q You do show a change though, for Youngstown itself?

A We have no change, but we cannot prove it from our figures. We are trying to run down the discrepancy with regard to the two figures.

Q I may be mis-reading this ?

A Let us see if we are correct? We appear to have the

same figures, although we became confused about the Youngstown townsite ourselves. No, that is all right.

Q I think I was looking at the wrong figures.

A There is no change in either one.

Now, the next is Bashaw in Census Division 8, page 1, and we have an upward revision as shown on line 2, column 14, of 13,717 million cubic feet. This revision was brought about by the drilling of an additional well, or additional wells in the Bashaw area over and beyond the initial wells, because in the D-3 subsequent development indicated the presence of commercial oil, that is, in the D-3, and the probability that the major portion of the gas, if not associated, is dissolved. There may be some actual gas cap gas in the field. The details are not sufficient from the well information to determine that precisely. It represents an increase in area primarily of the gas saturation in the D-3. We have no seismic data and insufficient structural data and, accordingly, did not attempt to draw an isopachous configuration of the D-3 since most of the data on the wells has been released. We used the factors in the D-3 reservoir that are better known to the north in Census Division 11, Leduc and Redwater.

The next field I refer to is Duhamel, Census Division 8, page 1 of Exhibit 10, line 10, column 14. This Duhamel field has been revised downward in a total amount of 39,607 million cubic feet from our previous estimate. The major reduction occurred in the Blairmore Glauconitic sand through the drilling

of an additional well. We had no geophysical data and expected that it would be more extensive there, and the Blairmore Glauconitic sand would be draped over the reef development, but with the pinchout on the reef there, the area of the productive gas was considerably reduced. Duhamel is not a major reserve, or a reserve of much consequence since the greater part of the gas, at least, a substantial portion, is associated with the production of oil, and our concept is that the major part of it will be utilized for field use within the confines of the field, and has little bearing upon the over-all Province picture.

The next field is the Stettler, Census Division 8, page 2 of Exhibit 10. You will note that under line 23, column 14, that we have an upward revision in the total amount of 9,596 million cubic feet in the D-2 and D-3 dissolved gas reserves. This revision was prompted by the additional development of wells primarily by Canadian Gulf. If you will refer to pages 17 and 18, in Exhibit 10, Census Division 8, and in Exhibit 4A, Census Division 8, pages 14 and 15, you will note in comparing page 14 in Exhibit 4A and page 17 in Exhibit 10, that the area previously considered as probable in the D-2 has been proved up by the drilling of additional wells between the two proved areas as shown on page 14 of Exhibit 4A. In section 22 on the map on page 17, Exhibit 10, well No. 3 was drilled in the southwest quarter of that section, about on our probable line as shown in section 22 on page 14 of Exhibit 4A. This well is a commercial D-2 oil well, and extends the area of

gas saturation, dissolved gas saturation, in the D-2, which was previously considered as probable. It makes it now proved. In effect, we consider the D-2 reservoir in Stettler is quite more defined by drilling and are no longer considering any major possibility in increases in reserve or area, and, accordingly, assign no probable or possible reserves. That is our general method of progression in the development of these fields that the proved, the probable areas and the possible areas will inevitably in the future coalesce with complete drilling, that is, the probable and possible areas to a finally proved area of gas saturation or oil saturation, and that area will be completely delimited.

The same type of revision is shown on page 15 in Exhibit 4A and page 18 in Exhibit 10, in that additional drilling has confirmed the contention that the probable reserves were real and can now be considered as proved. This work was based upon very detailed structural analysis, and, again, is subject to more controls from an engineering and geologic sense than most fields.

We now come to Viking-Kinsella, Census Division 10. In Exhibit 10, Census Division 10, page 2, line 20, column 4, we have a downward revision of our estimate in the Viking-Kinsella field in the amount of 74,639 million cubic feet.

Q MR. C. E. SMITH: Column 14, not 4?

A Column 14, yes, sir. We have reduced the proved area, proved reserves, in almost that amount on page, on the

reverse side of page 1, Census Division 10, in Exhibit 4A. The proved reserves we estimate as 950,593 million cubic feet. On page 2, Census Division 10, Exhibit 10, our current figure is 863,753 million cubic feet. This reduction has been brought about by a revision in our limits as shown by comparing page 4, Census Division 10, Exhibit 4A, and page 5, Census Division 10, Exhibit 10. The Imperial well which became the discovery well of the gas in the D-1 found that the Viking sand was tight, although present, and there was gas saturation, and our estimate is that approximately 3 feet of net sand is shown. This well is located in Township 46, Range 8, Section 18, Lsd. 1. That appears on page 5, Exhibit 10.

Q What description is that?

A Section 18, I believe. Section 18, Lsd. 1. Our concept of these limits is that with ultimate development they will be quite irregular and differ considerably from any picture which anyone may draw, but the over-all effect will not be appreciable. We also at this time have news of another well, the Texaco-Ranfurly No. 4, which is located, you will locate this on page 5 of Exhibit 10, and it is located in Township 50, Range 12, West, Section 29, approximately in the left centre of the section, about 1 mile south of the Ranfurly well, the original Ranfurly well.

(Go to page 296)

The original Ranfurly well, gas well estimated 16 feet of weighted sand thickness. We received the electrologs and core descriptions through the good services of Mr. Beach and in co-operation with the Texaco people and find that they have abandoned that well as sub-commercial. There are about three feet of gas saturation. We are not unduly disturbed by that occurrence since in 1930 a very similar situation arose in the exact centre of the Viking-Kinsella field and can be noted. If you will refer to Township 49 North, Range 12 West, Section 4, page 5 of Exhibit 10, you will note two wells, numbers 14 and 21. Well No. 14 was drilled and was a small gas well, 4 feet net saturation but North of it a bout six months or a year later well No. 21 was drilled and was abandoned with 200,000 cubic feet of gas developed on a drill stem test, or rather, developed with cable tools. At that time the only wells shown in that pool, then called the Viking, were drilled and the field was considered as delimited and that it was separate from Kinsella. Since then wells have been drilled well to the East. Well No. 23, for example, in Section 6, Township 49, Range 11. We will find in a field such as Viking-Kinsella that there will be a thinn ng and thickening of the thickness of s ands within the limits and variable gas saturation and until every section is drilled we will not know exactly what the thickness is and with the pressure decline information presently available we find that the estimates we have made from a volumetric and pressure decline basis are reasonably satisfactory.

My recollection is that the Board have requested through Dr. Govier that we prepare a pressure decline study of Viking-Kinsella field and whether we should submit that at this time or whether it would be appropriate now or whether the matter can be brought up later or not, I do not know, subject to counsel's wish.

Q MR. PORTER: I suggest we put that in now and we will have the discussion of this field at one place in the record for the convenience of everybody.

A If you will refer in Exhibit 10, Census Division 10, page 3, entitled "Viking-Kinsella Field Estimated Natural Gas Reserves, Viking sand (Revised)" on the left half of the page we have the volumetric data which is a slight modification of the volumetric data placed in evidence in Exhibit 4A, page 3. The basic difference is a slight revision in the area and a slight revision in the weighted average reservoir net Viking sand thickness. The estimated average thickness was reduced from 8.7 feet to 8.4 feet. The same ordinary factors were utilized, estimated average porosity 20%, estimated interstitial water 45% and the same pressure factors, estimated initial reservoir pressure and terminal reservoir pressure 150 pounds p.s.i.a. The result of that computation relating to line 18, Column 4 resulted in the initial recoverable gas to terminal pressure of 150 pounds p.s.i.a. as 1,015,217 million cubic feet. We then, after revising the volumetric estimate, proceeded to construct isobaric maps for the years 1950 and 1945. Those are those superimposed upon the isopachic maps or the sand thickness map, as

previously constructed. These maps are shown on pages 5 and 6 of Exhibit 10. The first map, page 5, shows the equal thickness contours. They are the heavier of the two sets of concentric lines and the equal bottom hole reservoir contour pressure, the lighter of the lines What this enables us to do is to weight the pressure by acre feet rather than by acres, such that we take into account the relatively poor contribution to the reservoir of the thinner pay thicknesses. It is the ideal pressure cumulative upon the material balance calculations to weight your reservoir pressures by reservoir volumes. In our volumetric estimate our thickness ranged from approximately 23 feet as a maximum, 22 feet as a maximum down to less than 1 foot. So that by weighting the contribution of the thinner areas is brought into proper proportion with the major part of the reservoir. As it happens it is so vast that we found that the ordinary arial weighting of the area was almost as precise. It was almost like straining at the gnat and swallowing the camel. There was as low a difference as 8 or 10 points difference between the area weighted and the volumetric weighted average. We find that to be the case where we have attempted to do the same thing in other fields. There are fields where there is a difference but in the large stratigraphic fields it is a minor problem. Page 6, map 6, Exhibit 10 shows the same kind of composite isobaric-isopachic data for 1950. Now in passing I would like to make one observation. If you will note the general area of the old Viking pool on page 6, Township 49, Range 13, you will note the lowest

contour pressure is 540 p.s.i.a. Compare that with the same general area of pressure contours on the first map on page 5 for the year 1945 and you will note the lowest contour pressure is 520 p.s.i.a. We have had 5 years production and yet the pressure of the Viking-Kinsella in that part of the field in 1950, or in part of the field at least, is 20 pounds higher than it was 5 years back. That indicates to us that these marginal areas so-called are making a substantial contribution of the upholding of the pressure picture and that we are not ready to write off any part of a gas reservoir so long as there is gas saturation in some measurable quantity in making our reserve estimate.

Q MR. GOODALL: Of course you have considered the small amount of gas that was taken out of the Viking section?

A Yes. However, we have had some time to build up the pressure.

Q THE CHAIRMAN: Are you through with Viking?

A No, sir. Now, turning to page 8 of Exhibit 10 we see a graphical representation of the reservoir pressure plotted against the cumulative gas production. Graphically we have calculated the weighted average and the volumetrically weighted average pressures obtained from planimetering maps 5 and 6 and plotted those pressures without respect to deviation in the gas, proved natural gas on the solid dots being 945 by 1950 with the cumulative production shown for the Viking-Kinsella field at that date. Above those lines we have plotted the deviated weighted average and volumetrically weighted average by the same method or

Jack F. Dougherty,
Dir. Ex. by Mr. Porter.

so-called pseudo pressure, as if the gas were proven natural gas instead of a natural gas subject to deviation. An extrapolation of the line through those points from the original reservoir pressure yields that deviated abandonment pressure or terminal pressure as we describe it of 153 p.s.i.a. indicating a probable ultimate reserve of 1,173,000 million cubic feet which should be compared with our volumetric estimate on line 18, 4, on page 3 of Exhibit 10.

(Go to page 301.)

A Initial recoverable gas terminal pressure of 150 psia. That figure is 1,015,217 million cubic feet. They are within relatively close correspondence. We do not attach too great importance to the close correspondence but the general order of magnitude inticates to us that our reservoir concept is not greatly in error. The individual calculations by the equal pound loss method, that is, as if we were merely extrapolating the 1945 pressures into the future from its original pressure and then the 1950 pressures, the pressure cumulative line into the future on the terminal pressure, and again show close correspondence as shown on page 3 of Exhibit 10 on line 18, columns 11 and 16. They are on the order of 1,170,000 odd million cubic feet. That increase only illustrates that the pressure cumulative history has apparently remained fairly constant over the period 1945-50, a period of maximum development of the wells, and a period of better metering and the best history.

Referring briefly to pages 5 and 6 again, Exhibit 10, we would like to have you note that on page 5 there are a number of well locations which are shown with a dotted circle around the well symbol. Those are wells completed after 1945, after the date of the pressure survey and the well data one would have in 1945. Those wells are now all currently gas wells, and we have indicated beside the well our estimates of pay thickness based upon electrical logs and other well data. You will note that the reservoir might very well have been considered conceivably smaller than as shown today by the development of those wells from 1945

to 1950. We think that until many more wells are drilled the configuration of the Viking-Kinsella will not be entirely established but that the pressure cumulative history with the volumetrically related pressures gives a reasonable estimate of the prospect for Viking-Kinsella. I believe that finishes Viking-Kinsella.

THE CHAIRMAN: We will adjourn until 2:00 o'clock.

(The Hearing then adjourned and resumed at 2:00 P.M.)

THE CHAIRMAN: Gentlemen, we received a request at noon today from the Ontario Fuel Controller asking that he and two other men representing, I believe, dealers and utility people there be allowed to make submissions to the Board. They ask that it be on one of three days, either the 17th, 18th or 19th of September. They informed us that the presentation would not be very long. We agreed, unless anybody has any objection, to let them appear on the 19th in the morning. We do not like to see this agenda interrupted any more than necessary but apparently those were the only three days they could appear.

J. F. DOUGHERTY (recalled)

examined by Mr. Porter, testified as follows:

Q Mr. Dougherty, just proceed with your testimony.

A Yes, sir. The next field I wish to refer to is Acheson. It is under census division 11, Exhibit 10, page 1.

J. F. Dougherty,
Dir. Ex. by Mr. Porter.

Under the Acheson field, line 1, column 14, we have a net increase of 31,249 million cubic feet of recoverable gas available for sale. The primary increases occurred in the Viking sand and the Basal Blairmore sand and the Leduc D-3 Dolomite as a dissolved gas reserve. The reason for this revision is the increased drilling which subsequently increased the areal extent of the field.

Referring to Exhibit 4-A, page 6, and census division 11, and Exhibit 11, census division 11, page 13, - - you might back up to page 12 in Exhibit 10 and compare that with page 5 on Exhibit 4-A. The increased drilling resulting from the extension of the field by Royalite-Stony Plain No. 10, 23, and associated wells in the vicinity of Section 23, Township 52, Range 26, west of the 4th, made the difference between the configuration of the Viking net gas sand as shown by the contrast between the isopach maps in Exhibit 4-A and 10. The proved areas were substantially increased, probable areas increased and the possible area increased.

Referring to pages 6 and 13 on 4-A and 10 respectively, you see again a similar modification but largely confined to possible gas saturation that was not confirmed by drill stem tests. The interpretation of the possible reserves in most of this reservoir is based on the electrical log correlations. With those wells, the advantage of drill stem tests gives no measurable quantities and quantities sufficient to consider as reservoirs. The same group of wells, total development of the area, has contributed

to this revision. Pages 7 and 14 on Exhibit 4-A and 10 respectively illustrate the modifications in the Lower Blairmore net gas sand areas of gas saturation as developed primarily by the Royalite-Stony Plain wells in Section 23 of Township 52, Range 26, West of the 4th, and the Pan-Western West Edmonton No. 2 well in Section 24, Township 52, Range 26, West of the 4th. The number of increased drill stem tests and additional electrical log data have extended the fields substantially. At the time of our previous submission we noted that the highest structural well lay on the east side of the Acheson field in approximately Section 24, Township 52, Range 26, west of the 4th. We had no additional control nor the structural configuration but had assumed that there might still be the east flank of the structure to be productive both in the lower horizon and in the Blairmore and Viking. Subsequent events have proved that extension. We did not submit isopach maps on the lower horizons as the data is changing from time to time, and we did not estimate reserves since the volumes of dissolved gas developed are still small. We made almost what might be called preliminary estimates but based upon preliminary isopaching that showed small volumes of gas in the D-2 and D-3 which we considered to be available for field use. There are distinct possibilities of larger drawings being developed but there is not sufficient data to extend them at this time. We have a downward revision on the Excelsior field in the amount of 569,000 cubic feet.

MR. PORTER: Mr. Chairman, I find myself having some difficulty following these figures and references. My difficulty is being somewhat aggravated by a continuous discussion that is going on in the room in an undertone. I would like to call attention to the need, I think, for quiet if this witness is to have a fair opportunity.

THE WITNESS: Referring to census division 11, again in Exhibit 10, page 2, line 14, column 14, we made minor corrections in the planimeter figures involving the proved and probable areas in the Viking and Basal Blairmore. The net result was a decrease of 569,569 million cubic feet for the Excelsior field. Additional wells drilled to the north in Excelsior, as shown on pages 16 and 17 of Exhibit 10, confirmed the generalized picture of the Viking and Lower Cretaceous gas reservoirs. But there were no significant changes that we felt necessary to make other than a correction in planimeter notes.

Golden Spike is the next field. It is also in census division 11. We are quite pleased with the result of several wells drilled within the last four months which confirmed the tentative ideas expressed in Exhibit 4-A, pages 22 and 24. The net effect of the changes was to increase our proved and probable reserves in the amount of 16,767,000 million cubic feet. Referring to division 11, Exhibit 10, page 3, the increases occur in the Viking sand as shown on line 9, column 14, the Basal Blairmore A-sand and the

J. F. Dougherty,
Dir. Ex. by Mr. Porter.

Basal Blairmore B-sand. Comparing the map exhibits for Golden Spike, Exhibit 10, pages 21, 22 and 23, with the similar exhibit in Exhibit 4-A, pages 22, 23 and 24, in census division 11 - - I would like to make a correction there. We divided the reservoir in the dissolved and non-associated gas and correspondening exhibits and maps in volume 4-A are 16, 17 and 18, and 21, 22 and 23 in Exhibit 10 are for the same horizons. At the time Exhibit 4-A was prepared there was a dearth of drill stem testing in a number of the parts of the field which we considered as having good gas possibilities, and that was particularly true of the Blairmore B sand which is shown on page 18. If you will contrast 18 with page 23 you will note that in the period between the preparation of these two exhibits that what was just considered as bare possible reserves have now been transferred and confirmed as having considerable volume of proved and probable reserves. This configuration originally estimated in volume 4-A was based upon carrying electrical log correlations and electrical characteristics from the Leduc field over to Golden Spike for this particular sand zone, and we estimated that there was a gas-water contact somewhere in the vicinity of minus 2170, sub-sea elevation, as shown on Exhibit 18. And in addition, our men, using the electrical log, estimated net gas pay thickness without having drill stem tests to confirm it. Since then the Anglo-Calmont No. 1 well, as shown on page 23, Exhibit 10, was drilled in about the centre of Section 34, Township 51,

Range 27, West of the 4th. That well is shown as a location on page 18 of Exhibit 4-A without designation by name. This gas well, rather, this producer of oil at depths in the Devonian did drill stem very substantial volumes of gas in this B-Blairmore sand which confirmed our basic interpretation that there was gas saturation in substantial quantity in that B sand even though we had no confirmatory drill stem tests in the April 15th submission.

(Go to page 308)

J. F. Dougherty,
Dir. Ex. by Mr. Porter

I would like to give just a brief summary of those drillstem tests. Those for the Anglo-Calmont No. 1 well, in our so-called "B" Blairmore sand, the top at approximately 4398 feet, and there were a series of drillstem tests taken, 1, 2, 3, 4, 5 in number, covering completely the interval from 4400 to 4435 feet. They are respectively 7.2 million cubic feet, 4 million cubic feet, 5.3 million cubic feet, 6 million cubic feet and 700,000 cubic feet, with 90 feet of salt water in the last drillstem test. We found that the series of drillstem tests confirmed almost exactly the gas/water contact from the electrical log, from a study of the Leduc log.

In addition there were tests in the "A" sand immediately above. However, we had already some considerable amount of control on "A" sand drillstem tests on other wells. However, turning back to page 17 of Exhibit 4A, and comparing it with page 22 of Exhibit 10, we find that the No. 1 Anglo-Calmont well was shown in Section 34 on page 17 of Exhibit 4A as being in a probable gas reserve area, with a thickness of perhaps less than 5 feet. You will note that on page 22 of Exhibit 10, that the Anglo-Calmont has now, by electrical log interpretation and by reason of a 5 million foot drillstem test or tests, an estimated gas sand thickness of 14 feet. So that we felt that the reason was sufficient in these data to expand our proved area, to expand the probable areas and to further reduce the possible areas.

There were additional extensions in the Blairmore "A" sand, which changed the configuration of the proved and probable area in the south end of the Golden Spike field, but these were not of great moment. We were able to estimate thickness by reason of having electrical logs for use which were not available at the time Map No. 17 in Exhibit 4A was made.

I think the next field that bears examination....

Q THE CHAIRMAN: Mr. Dougherty, before you go from Golden Spike, were drillstem tests examined from any of those Imperial wells to indicate any production from those sands?

A Yes, sir.

Q Or only the Anglo-Calmont?

A I do not have those right at hand. However, we will go through the files and pull out such of those as have drillstem tests.

Q All right. Possibly you can tell me if your original map was based on some drillstem tests or purely on your electrolog interpretation?

A Some drillstem tests. The main change was in the Blairmore "B" where we had no drillstem tests, and left that as it is just in our original interpretation. The changes in the other wells have been a matter of extension of previously known data. There are a number of drillstem tests in that area, but it would take the electrical logs to pin down its precise area, but I am quite sure there are some in that area. My primary interest was Blairmore "B", of which we have no confirmatory evidence.

The next field in which some modification of reserve estimates was required, was the Leduc field, Census Division 11. Referring to page 1 of Exhibit 10 under Census Division 11, line 23, column 14, there was a downward revision of 14,400 million cubic feet in the lower Blairmore (composite) sand map or reserve. And then, in addition, as you will note, under column 16, under Leduc-Woodbend opposite the Leduc B-3 Dolomite, the associated gas, the vas cap gas, we had an increase of 30,551 million cubic feet. That is under the column headed "Reserves Probably Deferred by Oil Production". A downward revision of the lower Blairmore sand was a minor change in the limits of the field. The increase in the associated gas reservoir of the D-3 Dolomite was brought about by some recent drilling which extended the developed area for D-3 oil and gas production. The areal changes are probably too small to note except by a very close inspection of maps, but they occurred at the southern limits of the Leduc field, and can be ascertained by close comparison of the two sets of maps in the respective exhibits.

I would like, however, to call your attention to pages 32 and 33, under Census Division 11 in Exhibit 10, which might bear a little explanation. These maps are index maps respectively of the Viking tests used in delimiting the Viking gas reserves and the Blairmore gas reserves. The plan utilized was by comprehensive study of all of the electrical logs and of all of the drillstem tests recorded for the Leduc field

to note the positive drillstem tests, the negative drillstem tests, and those wells which were not drillstem tested in these respective sands. On each map a star represents the positive drillstem tests, a solid black square wells having negative drillstem tests, and an x by the wells unsupported by drillstem tests. In the Viking, which we felt had a very limited reserve, both electrical log data and the absence of a general pattern of drillstem tests confirmed our contention that the reserves in the Viking were limited.

Now, on page 33, the same pattern of test symbols holds. We find that there is a fair distribution of positive drillstem tests throughout the length of the field and across the breadth of the field. There are a number of negative tests, but by close electrical log correlation, making a number of cross-sections and pinning down the individual sands in the Blairmore to the extent that we were able to, we found that we could calculate and determine within the limits of the data, a very sizeable volume of proved and probable gas saturation in the Blairmore sand from the basis of the positive drillstem tests and the electrical log correlation. We have brought with us, in case anyone is interested, a boxful of all the Leduc wells' drillstem test data, which we will be very glad to discuss in detail on cross-examination.

The next field I wish to refer to is the Jarvie field, which is Census Division 14. Referring to page 2, Census Division 14, Exhibit 10. We made some

minor revisions in the Viking sand and the Blairmore Glauconitic and the Basal Blairmore as shown in line 18, column 14, and the total amount represents an increase of 6,261 million cubic feet. This represented changes in our concept of the proved area as brought about by re-working the data. There were no substantial increases, and we did not prepare any isopachous maps for submission since the data was somewhat limited.

The first two changes are mathematical, and the second change, the change in the Basal Blairmore sand, was a matter of reinterpretation of some of the well log data.

Legal-Morinville, which is the composite area, as we designate it, which we have arbitrarily placed in Census Division 14, since Legal is in 14, was modified by an increase in the amount of 68,201 million cubic feet as shown in Exhibit 10, Census Division 14, page 3. You will note that on line 20, the group of lines beginning with line 20 and column 14, that an estimate was made for the Viking sand which is a new estimate which did not appear in our original submission, although we were aware that the Cardiff Giant well had indicated some Viking gas, but subsequent data enabled us to place an estimate on this gas, and since it is an original estimate, I will let Mr. Trostel take care of the details. However, the net effect was that we introduced on page 10 of this same exhibit, in Census Division 14, a new calculation sheet, and on page 13 a new isopachous map of the net Viking gas sand in the Cardiff area. The data was based on drillstem tests and electrical log data

on the Cardiff Giant, the Imperial Morinville and Ajax wells.

The next change, referring again to page 3, Census Division 11, Exhibit 10, appears in the Blairmore sands in which there was some increase estimated at 63,603 million cubic feet. The change in this estimate again can best be seen by examining page 14 of this exhibit of this Census Division and comparing it with the equivalent maps in Census Division 14 of Exhibit 4A, page 19 or 20. Page 20.

We have made no major revision except to the south. As you will note on page 14 of Exhibit 10, Census Division 14, the Imperial Sturgeon well was considered to prove up a substantial area, which was indicated by some of the wells drilled in the vicinity of Volmer at the time we prepared the original submission. The Sturgeon well was located in Township 54, Range 25, West of 4. I cannot tell the section number from the irregular township pattern.

(Go to page 314)

We think, however, that this estimate may be revised in future down to some extent by reason of one of the Ajax wells, No. 3, which is shown on page 14 in Township 55, Range 25, West of 4, in what looks like Section 36, just North about two miles from the small town of Cardiff on the rail line. This well found the sand low in the Lower Cretaceous and a steep dip along the East side of the Legal-Morinville and the Morinville area, particularly the Morinville portion of the Legal-Morinville area would reduce those areas probably in a lesser amount by the additions made by reason of the Sturgeon well and a slight increase in the proved area as delimited by the Morinville No. 3 well, which is located -- the Imperial Morinville No. 3 well located in Township 56, Range 24, West, Section 32. So that our over-all estimate up to the minute would not increase the Legal-Morinville area by quite that 68 billion cubic feet. It would be some portion of that. How much we cannot determine as yet. However, the net effect is to increase our estimate slightly over the last three to six months' period. We also have a change in the -- rather, a confirmatory test in the Legal-Weybrook portion of the Legal-Morinville area which is shown on page 14 of Census Division No. 14, of Exhibit 10. The Northwestern Utilities No. 1 well does not appear on these maps but can be located as follows, in Township 58 North Range 24 West of 4, about two miles North East of Imperial Weybrook No. 1 well in Section 4, Legal Sub-Division 6. We found that according to the latest scout report that 370,000 cubic feet of gas were obtained in the Lower Cretaceous. You will note

the spotting of that well, it is right on our zero possible reservoir limit line. We were lucky there. By the same token the Viking reservoir which appeared in Exhibit 4A, Census Division 14, page 19, in the Legal-Weybrook area if the Northwest Utilities well is placed on the map again in Township 58, Range 24, West of 4 in Section 4, it will lie on the zero isopach line for the Legal-Weybrook Viking net gas sand, on the isopachous map. That well encountered 2½ million cubic feet of gas in the Viking. The thickness shown there would have to be revised upward and the eastward extent of the reservoir modified because there is some thickness there. It is perhaps minor, as we had thought likely but as I understood Mr. Steer in previous remarks he said that one or two or three feet of Viking sand were encountered in that well. The electrolog has not been released to us as yet. I believe those are the major changes and observations I wish to make from the general Legal-Morinville area.

The next field of interest is Picardville in the same Census Division, Census Division 14. The map, page 19 in Exhibit 4A, Census Division 14, that We were just looking at depicts the original isopachous? configuration of the net gas sand of the Picardville field. Since that time Canadian Delhi Company have completed their No. 3 well in which the isopachous map is shown on page 4 of Exhibit 10 and in Census Division 14. There is an increase in the amount of 27,150 million cubic feet, a portion of which, as shown on the map, lies underlying 25 and in Column 14 is brought about by the explanation of the

Viking sand gas saturation in Picardville field proper. And a slight extension in the Basal Blairmore or a new reserve in the Basal Blairmore sand of the Westlock portion of the Picardville-Westlock area. This latter increase or new reserve is 62,332 million cubic feet. The revision in Picardville up was brought about by the completion of No. 2 Canadian Delhi. At the time of the last hearing it was then in the process of being completed and the completion of No. 3 in the Picardville field within the last 30 days. This can be pointed out by referring to page 18 in Exhibit 10, Census Division 14, wherein we have re-drafted and re-examined the Picardville and the Picardville-Westlock area to incorporate the net sand encountered in the No. 2 Canadian Delhi well, which is shown in Township 59, Range 27, West of 4, in Section 1 I think. That township line is not clear. At least it is one mile approximately north and westerly from the Union Picardville No. 1 well, which is north of Picardville. The No. 3 well which has just been completed can be located as follows, Township 59, Range 26, West section 4 and approximately in the centre of the North West quarter. It would be about two miles due East of the No. 2 well. This well is a small well in the Viking sand in which most of the gas occurs in the first S. P. Kick on the electrolog and might require some modification of our thickness estimates in the vicinity of that well. So that the net effect of the drilling between April 15th and August 1st would be to have an increase in reserves slightly less than the 27,150 million cubic feet as shown in Exhibit 10, Census Division 14.

The over-all increase is a result of the drilling of the Canadian Delhi Oil Corporation in this prospect.

The last revision which I wish to refer to is associated with the drilling in the Whitelaw area, that is Census Division 16, in Exhibit 10, page 2. The group of lines associated with line 9 in column 14 show that the Upper Nikanassin sand was increased substantially in reserve in the amount of 153,745 million cubic feet with a downward revision of the Upper Triassic sand in the same field in the amount of 86,819 million cubic feet, a net increase in the amount of 56,826 million cubic feet for the Whitelaw area. Referring to the appended maps Exhibits pages 7 and 8 in Census Division 16, Exhibit 10, and comparing those with the maps Exhibit in Exhibit 4A, Census Division 16, pages 8, 9 and 10 - I have it 8 and 10 in my volume. Is there a page 9? I do not see one.

MR. C. E. SMITH: I have not got one either.

A It must not exist. I suspect that is a typographical error.

MR. C. E. SMITH: Mr. King has one here.

MR. KING: There is one in this one.

A That is correct. There may be some missing in a few of the copies. You will note in Exhibit 4A that we do not include the McMurray or Nikanassin sand map for the reason that our data was rather limited and we did not want to stick our necks out that far. However, with the additional wells and a little closer correlation between the drillstem tests and the electrologs we prepared the map shown on page 7 in Census Division 16 of Exhibit 10, with the net thicknesses

of the Nikanassin sand as demonstrated by cores, electrologs and drillstem tests, centering around the Shell-British American Whitelaw No. 2 and No. 1 and No. 3, Shell Bluesky and the Shell Bingo Lake. At the time of our original submission the No. 3 well, which is in Township 82, Range 2, West of 6, in Section 20, was a drilling well and has since proved up gas in that vicinity to extend the gas saturation in the Nikanassin or McMurray to the North West. The Shell-British American No. 4 Whitelaw proved up the East, Southeast edge of the McMurray and Nikanassin gas accumulation in Township 81, Range 1, West of the 6th, and in Section 34.

Referring now to page 8 of Exhibit 10, Census Division 16, we have the Upper Triassic configuration of net gas sand as delimited now by the completion of Shell-British American Whitelaw No. 3 in Township 82, Range 2, West of the 6th, which found no net effective saturation in the Upper Triassic. Our previous standard estimate had smoothed out the general configuration of the gas saturation based upon a discussion of the seismic picture with the operators drilling in the Whitelaw field. But the limitations of permeability and porosity in the No. 3 well would not yield commercial gas. The Shell-British American Whitelaw 5, which we have considered to be the outside limits on our previous work, proved to have no net gas saturation in the Upper Triassic. The major increase then lies in the McMurray or Nikanassin sands. There have been no changes in the Permo-Pennsylvania. It has a very limited extent and no changes were warranted.

Jack F. Dougherty,
Dir. Ex. by Mr. Porter.

I believe that covers the downward and upward revisions and corrections to Exhibits 4 and 4A as shown in Exhibit 10, for the Trans-Canada Pipe Lines Company.

(Go to page 320.)

MR. PORTER: I think Mr. Dougherty is now available for cross-examination on this and his previous testimony.

THE CHAIRMAN: Mr. Steer?

MR. STEER: Mr. Chairman, before I cross-examine Mr. Dougherty I would like very much an opportunity of reviewing with Mr. Davis the evidence that Mr. Dougherty has given today and cross-examine him in one flight instead of two.

THE CHAIRMAN: Does anyone else wish to cross-examine Mr. Dougherty?

MR. S.B. SMITH: At the moment we are not prepared. My suggestion would be that perhaps Mr. Porter would lead all his direct evidence and by that time I hope to be ready to cross-examine. We got yesterday for the first time volumes 1, 2 and 3, which Mr. Porter was kind enough to deliver to me. My time has been very limited.

MR. PORTER: Well, Mr. Chairman, volumes 1 and 2 were submitted in evidence to this Board at the Hearings in Edmonton some months ago and to the number of more than 60 have been in the hands of those interested in this Hearing. All of the principles on which Mr. Dougherty intimated his survey was made were established in evidence. His testimony today is purely an extension of the results of the application of those principles to the same fields in the light of subsequent information that has come to hand since that Hearing. Now, except as to those few areas on which new information is avail-

able my friends are asking to postpone cross-examination on something that has been in their hands for months. Now, if they want a shorter time to bring themselves up to date on 13 or 14 fields out of a total of some 120, all right, but I do not have any intention of altering the normal course of submitting my evidence by each witness who will then be subjected to cross-examination, assuming there has been a reasonable time for those who want to examine to digest his testimony. And I do suggest, respectfully, that an interval from spring to fall with detail of this information in my friends' hands and in their advisors' hands throughout the whole of that period is somewhere near adequate for them to understand it, although I share their difficulty, it is large.

MR. S.B. SMITH: Well, Mr. Chairman, I suggest no criticism of Mr. Porter at all. I was not present at the May Hearing as I was engaged elsewhere. Mr. Porter will remember that I wrote him at that time asking him for copies of these volumes and he was kind enough to write back and say they would be available to me as soon as they were printed, or words to that effect, and they were re-printed and I got them yesterday afternoon.

MR. PORTER: Well, I am sorry, sir, you were not in the scramble.

MR. C.E. SMITH: Round three coming up. Next!

THE CHAIRMAN: Mr. Smith?

MR. C.E. SMITH: I am not prepared to go on with Mr. Dougherty at this time, either. While it is quite

true what Mr. Porter said, what Mr. Dougherty has said here during today is very, very much more than what he said in Edmonton, and while I did take the bit in my teeth and asked him a few stupid questions I say in view of what has occurred here today I would like the opportunity of going over his evidence with Mr. King, who also advises me. I can ask him what he meant by saying "We don't want to stick out our necks that far," but that is not going to help us. I want to know how far they have been out before this fight.

MR. PORTER: Mr. Chairman, in those circumstances I am going to ask that we adjourn and stand Mr. Dougherty over to have his testimony the subject of study by these gentlemen over the weekend with the hope that by Monday they will be able to go on. I do not think it is useful to add to this indigestible mass more indigestible stuff by Mr. Trostel.

MR. C.E. SMITH: Why couldn't Mr. Trostel go on? Does it affect your plan?

MR. PORTER: Why, of course it does. I am just adopting the normal practice.

MR. C.E.SMITH: We are not conducting a party party lawsuit; not with me, you are not, anyway. It might help us not to ask for some further adjournment after Mr. Frostel goes on, that is all I have in mind. Surely it does not disturb you that much to have Mr. Frostel heard now, does it? I say that most nicely. It has been done before. There is lots of precedent for it in this Hearing.

Q DR. GOVIER: Mr. Dougherty, I have a few questions I would like to ask later because I would like to spend a little more time on this also, but there is one question which I was going to ask that you might want to do a little preparation on, so perhaps it would be fair if I asked that today.

A I would appreciate it, yes, sir.

Q It is in connection with your estimate on the Viking-Kinsella field. You will recall this morning that you presented essentially four figures. One was the volumetric estimate, one was the result of agraphical pressure decline, and two others were closely related figures on your equal pound loss method. What I wanted to ask, Mr. Dougherty, is essentially this: Could you work out something for the Board that would indicate to us the sensitivity of the apparent check between the volumetric and the pressure decline method with respect to the area chosen?

A Yes, sir.

Q Do you see what I mean?

A Yes, sir.

Q I may elaborate just a little bit. Suppose you chose an area 25 per cent greater than you had chosen, and suppose on the basis of that area you had estimated by the volumetric method and then proceeded to estimate by pressure decline using volumetric weighted pressures, would you still get an apparent check, that is what I would like to know.

A Yes, sir. The only modification would be in the deviation of the weighted average pressure, and since when we used

the calculation of weighted average pressure on an areal basis irrespective of thickness, we found only a 10 pound deviation from the weighted volumetric average for 1950 and a 4 pound difference in the case of the 1945 figures. I have in the back of my mind that the change would not be significant so long as the limit chosen for the pressure decline calculation were outside the indicated drainage area by the extrapolation of the pressure contours. That area does not come into the extrapolation of that curve, it only comes into the weighting sense in both cases. The reserves estimated by pressure decline, they are by extrapolation of pressures graphically or by the equal pound loss method. The same proved area was utilized. So the only modification would be in reducing the area at virgin pressure to a point where it is co-extensive to the farthest indicated area of depletion, and that change in the weighted average pressure, I believe, by almost visual expression of the maps would indicate that it would not be large, it would be a somewhat parallel curve shifted on the graphical solution, not perhaps parallel to the curve on there but at some slight angle to the deviation in the volumes recorded at the intersection of that line, that the terminal point of pressure be, oh, perhaps a matter of 10 or 15 per cent. That is an opinion right now but I will, within the limits of the material at hand, attempt to check that this week-end.

Q What I am really driving at is this, when a person examines the results of your volumetric system on the one

hand and the pressure decline method on the other hand, one is struck by the fact that they come out very close.

A We were very much surprised ourselves.

Q I would like to know whether that is really evidence that should be used in supporting the fact that those estimates are correct, or whether you would get the same type of check even if the answer were wrong?

A I rather think the close correspondence is coincident. The general close correspondence is not. It is a matter that within the devéloped area of pressure decline apparently the thickness was chosen and the practice relating to the volumetric calculation must have been in close correspondence or at least balanced out so that the exact acre feet, the exact saturation, closely approximated the net volume of gas indicated to pressure decline because the two studies were not made at the same time but at an interval of perhaps two months apart. However, there is little modification on the volumetric data,so that in my own mind the close correspondence does not mean too much, but the general correspondence within 20 per cent is, I think, significant.

Q It is fair to say this, though, is it, Mr. Dougherty, that the area which you have assumed in the volumetric calculation is the same area which you have taken in the pressure decline calculation in weighting the pressures?

A That is correct.

Q I would appreciate it if you would look into it and perhaps enlighten us a little further on Monday.

A I think if we can find a planimeter we might be able to

for the purposes of illustration attempt to utilize the area most closely indicated as being developed. You see, the only change will be in the weighting of the pressures. There will be no change in the cumulative production so that the only shift will be in the relationship between those two sets of pressures and, say, one set for the smaller area and a set for the larger. It will take a very large change in area, that is, of virgin reservoir pressure area, to modify the related average pressure to a very considerable extent, and in so doing I would not want to violate the fact that we would not include or we would exclude any area which showed gas saturation, because that is part of the reservoir whether it is in the 2-foot zone or the 20-foot zone.

Q Well, you might try it, as you suggest, with the area that is definitely known to be productive. Perhaps you would come out with an answer similar to Mr. Davis's under the circumstances, would you?

A It is quite possible. I rather doubt it myself.

Q I also understand Mr. Davis had it checked but at a little lower level.

A I think there is always going to be a difference of opinion as to the extent of the gas saturation. Except for some more wells I do not know that there can be a complete reconciliation because there appears to be a fundamental difference of opinion as to what constitutes the gas reservoir in an effective sand. However, we will attempt to do what we can within the limits on that sort of a check.

Q Thank you, Mr. Dougherty.

THE CHAIRMAN: We will adjourn until Monday morning.

MR. McDONALD: I might mention, Mr. Chairman, that Dr. Hetherington will be available Monday morning for cross-examination.

(The Hearing then adjourned until 9:30 A.M., Monday September 17th, 1951.)